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METHODS

of

Heating, Ventilation and Sanitation

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METHODS
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Report of a COMMISSION appointed by the
Governor and the State Board of Education,
State of Montana,
for the purpose of finding the best methods of heating, ventilation and
sanitation, for adoption in the Public Buildings
of the Commonwealth

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❁ Introduction ❁

THIS report is a valuable addition to the library of all Boards of Education, Trustees of Colleges and Public Buildings, and all others who are responsible for the proper ventilation and sanitation of such buildings, as well as to the general public, because this is, so far known, the first exhaustive investigation, by disinterested experts, of the actual workings of the prevailing types of construction and the systems used in the public buildings of the United States, and the conclusions reached, are not theories, but demonstrated facts from living examples.

It is hardly possible for the reader to understand the amount of labor and time spent in the gathering up of this data; in the analysis of the air; the classification of readings from thermometer, hydrometer, and anemometer; the preparation of tables of cost of apparatus, cost of maintenance, cost of fuel, cost of repairs; percentages of impurities; number of pupils per teacher, lighting, seating, etc. Any one interested can apply to the Secretary of the Commission, Architect John C. Paulsen, Helena, Montana, for items mentioned above, which were too bulky to include in the report.

The text of the report herewith given is an exact copy as submitted, and may be verified by reference to the official records of the State of Montana by application to the Governor.

The marginal readings and notes in small type are by the editor.

This pamphlet is published for free distribution, and will be mailed on application to

The Peck-Williamson Heating and Ventilating Co.

Offices at { CINCINNATI
SAN FRANCISCO
CHICAGO
ST. LOUIS
PITTSBURG
NEW YORK

9076

❁ Conclusions ❁

The conclusions reached in this report are:

That a heating system using altogether indirect radiation is essential to the proper ventilation of a public building.

That the best method of heating the radiating surface is by fire, rather than by steam or hot water.

That the best exemplification of this method in the United States is the work as erected by the Peck-Williamson Heating and Ventilating Co.

The report which follows was adopted unanimously by the Governor and the Montana State Board of Education, and, as a consequence, the following contracts have been awarded to the above-mentioned Company, and the work is now being erected (August 1896), in the following public buildings of the State.

BOZEMAN, Montana.—State Agricultural College Buildings.

BOULDER, Montana.—State Deaf and Dumb Asylum.

DILLON, Montana.—State Normal School Buildings.

BUTTE, Montana.—State "School of Mines" Buildings.

"	"	City High School.
"	"	Central School Building.
"	"	West Broadway School.
"	"	Colorado Street School.
"	"	Kenwood School.

Report
OF THE
**Investigating Commission of the State Board of
Education on Heating, Ventilating
and Sanitation**

*To His Excellency the Governor,
and the State Board of Education,*

GENTLEMEN :

We have the honor to submit herewith our report as a Commission appointed by the Governor to visit Eastern cities for the purpose of investigating different systems of heating, ventilating and sanitary appliances in public and educational buildings.

This examination and investigation has been conducted with a view of the selection of such a system for the public buildings of Montana, under the control of the State Board of Education, as will insure to the State the best possible results with the least outlay, as to the first cost, maintenance, etc.

The Commission, consisting of T. E. Collins, Walter Cooper, and J. C. Paulsen, left their respective homes December 3, 1895, meeting for organization in St. Paul, Minn., on December 5, 1895, and returning, arrived in Montana, February 3, 1896. T. E. Collins was appointed Chairman, and J. C. Paulsen, Secretary of the Commission.

Beginning at Minneapolis and St. Paul, we visited in turn the following cities: Minneapolis, St. Paul, Milwaukee, Chicago, Detroit, Buffalo, Syracuse, Boston, Hyde Park, Lowell, New York, Brooklyn, Washington, Norfolk, Portsmouth, Kenton, Hamilton, and Cincinnati, inspecting and testing the heating, ventilating and sanitary apparatus in one hundred and twenty-seven buildings. These statements can hardly give to those not familiar with the matter, an adequate idea of the vast amount of work performed by this Commission.

Our method consisted of :

First—Calling on the proper officials for permission to visit and inspect the buildings.

**Object of
Appointment**

**Personnel of
the Commission**

Places

Methods

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Second—When possible, to see the Architect or Engineer who prepared the designs, and have his explanation of methods and plans, or better, to go with us to the building and there explain the apparatus and its workings.

Third—Examination as to cleanliness, comfort, convenience, lighting, seating, heating, ventilating and sanitary apparatus, the cost of the plant, and cost of maintenance.

Fourth—Tests by anemometer, thermometer, and hydrometer in a great number of buildings of the amount of humidity-temperature and ventilation, except in many cases, where the condition of *no ventilation* was so apparent that a scientific test was unnecessary. •

Fifth—Investigation of the kind of Heat Regulation used for controlling the temperature—whether hand or automatic.

Sixth—Interviews with Principals, Professors, Teachers, Janitors and all who were using the apparatus daily, as to the intelligence of those in charge of the apparatus and its efficiency, sufficiency, durability and economy in fuel and management.

We do not give a detailed report of each building visited, for the reason that to describe the apparatus in one will often serve to describe a similar system in many others. Therefore, to avoid such repetitions, we will mention and give a more or less detailed description of all the systems we found in use, and follow with the reasons for our preference.

No Record of
a Previous
Tour with a
Like Object

We found no reference of a similar tour of investigation having been made by *disinterested* parties, viewing *all* systems for the purpose of deciding which gives the best results, and we have been obliged to depend mainly upon our observation and research for information, for the reason that no complete digest of all employed systems is obtainable, except that to be found in the catalogues of the manufacturer, whose views are necessarily pointed in favor of his own system, or in books written by the theorist, no two of whom are found to agree and whose opinions are frequently warped by local influence or individual prejudice. Our own observation goes to prove this, for we found the same system being torn out of one building, because of failure in one city, finding favor and adoption in another new building in another locality.

Strongest
Conviction

Our strongest conviction now is, since finishing this investigation, that the proper ventilation of the rooms of all Educational Institutions and all Public Buildings is of supreme importance, and our rejection of many systems presented to us is because that *no ventilation* or *inadequate ventilation* would be the result of their adoption.

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It is a lamentable fact that most buildings are constructed without proper provisions for ventilation, and it must be because this subject is not properly understood, nor its importance sufficiently appreciated, that the public at large do not insist upon and provide for the necessary expense to ventilate their buildings.

One of the chief reasons why improved ventilation has not received the consideration it should have, undoubtedly lies in the fact that while every intelligent person emphasizes the necessity for proper ventilation, there is a lack of authentic data to substantiate such statements.

In the last fifteen years this subject has attracted the attention of the Specialist, and while volume upon volume has been written about it by men who have made the subject a life study, the trouble is, and has been, to popularize it.

The works published as a rule are Technical and Theoretical, and are read mainly by students or engineers interested in the science.

If the evil effect of impure air was generally known in our State, public sentiment would solve the problem in a short time by compelling the passage of laws by our Legislature looking to improved methods of ventilation in all public buildings. Heating and ventilation should be treated as one of the primary requisites of a building, and as much thought and attention should be given to this subject as to the general outline of the structure, or even to the foundation itself.

To those who look upon this subject as largely one of sentiment, a few facts bearing upon the hygienic side of the question may be convincing. Any physician or other expert who has given the subject due consideration will tell you that proper ventilation is absolutely necessary to the health of the occupants of any educational or public building, and will save almost every year in doctor's bills a large share, if not all, the original cost of such ventilation. No investment pays so well as that, the income of which is good health, for in securing this return, we secure with it, as a possibility at least, nearly everything which life can give of enjoyment and happiness.

The New York Board of Health, treating upon the primary cause of disease, makes the remarkable statement:

"That forty per cent. of all deaths are caused by breathing impure air."

Dr. Playfair asserts:

"That in modern hygiene, nothing is more conclusively shown than the fact that a vitiated atmosphere is the most fruitful source of disease."

Prof. S. H. Woodbridge, of the Massachusetts Institute of Technology, tells us, basing his statements upon carefully collected data, that:

**Laws Should
be Enacted
Compelling
the Ventila-
tion of All
Public Build-
ings**

**Economy of
Life and
Health**

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"Death rates have been reduced by the introduction of efficient ventilating systems in children's hospitals from 50 to 5 per cent.; in surgical wards of general hospitals, from 44 to 13 per cent.; in army hospitals, from 23 to 6 per cent., and in prisons, from 30 to 8 per cent."

Dr. A. N. Bell, a noted specialist, stated in a paper read before a Public Health Association, that:

"The depressed state of the organism under the prevailing conditions of badly ventilated schoolrooms not only predisposes to epidemic diseases, but the liability to, and danger of, all diseases are intensified, and vicissitudes of weather, which, under favorable circumstances may be encountered with impunity, under these depressing influences become dangerous perils; and doubtless much that is attributed to the season of the year supposed to be predisposing to scarlet fever, measles, whooping cough, diphtheria, and some other common affections of children, is due to the same cause."

We learned while in Washington, from trustworthy sources, that a marked decrease in absence from duty on account of sickness is shown on the part of the employes in the departments, where modern methods of ventilation have been introduced. This is more particularly noticeable in the new Pension Building where a careful record is kept, and the decrease in absence on account of sickness is shown to be forty-six per cent. When figured down to a basis of dollars and cents this shows a splendid financial return from improved ventilation.

**United States
Government
Buildings**

That the ventilation of the Treasury Building is very imperfect is best shown by the following incident of our visit to the National Capital. During our investigation of heating and ventilating systems in that city, we called on Secretary Carlisle to obtain permission for investigating the U. S. Government Buildings, and being ushered into the Secretary's office, a room about 29'x26'x14' high, we did not find Mr. Carlisle present. A few minutes later, however, he appeared, and apologized for not being present, stating, as a reason, that the *ventilation* of this room was so *insufficient* that a change was often required, a continuous occupation of his room being impossible. We particularly called his attention to the purpose of our visit, and he stated that he had in his room the best window ventilation attainable, and still it was a failure. This further confirmed our belief that ventilation through doors and windows is a signal failure, and also that it is as essential to ventilate a room occupied by a few persons as one occupied by many.

One of Dr. Franklin's wise sayings that "Public Health is Public Wealth" was never a more self-evident axiom than in this age of mammoth and sky-scraping structures, when the majority

Report of Montana State Commission.

of the people are compelled to spend nearly two-thirds of their time confined within four walls, is it not self-evident then, that it is the duty of those who are responsible by virtue of their offices — Legislators, City Councillors and Boards of Education — for the well-being and health of the people that good heating, good ventilation and proper sanitation be carefully studied and provided?

A classification of the heating systems in use will result in four divisions, each class having several subdivisions, viz:

- 1—Stoves,
- 2—Steam,
- 3—Hot Water,
- 4—Warm Air.

General
Divisions

I—STOVES.

Stove heating is in two forms: The common stove, and ventilating stove.

The first is, of course, in general use, but in the larger and better buildings of to-day is unknown. It should have no place in the schoolroom, even in the most unpretentious district building. It takes up the place of eight pupils, because no one can sit near it. It makes dirt and is unsightly, and it goes without saying that with it, it is out of the question to maintain a uniform temperature in all parts of the room, and no adequate ventilation is possible. The second, the Schoolroom Heating and Ventilating Stove: this is a great improvement over the common stove because it provides for the ventilation of the room. The air supply is taken from outside, passing under the floor to the base of the heater and up between the stove proper and the casing, and distributes in the room from the top. The casing is double, and a current of cold air between the casing makes the sides of the heater cool. Pupils can sit near it without discomfort. A ventilating flue or stack should be provided to remove the foul air.

Common
Stoves Not
Approved

We would recommend the adoption of the ventilating stove in district schools or other buildings of not over one story in height, and where there are *no basements*. There are several stoves of this description in the market. Any of them we have seen are good. In their use care must be taken to provide vent flue and the means to warm it. The stove *admits* the *fresh* air. The vent flue exhausts the foul air.

"The Ideal"
Heater and
Ventilator,
Manufactured
by The Peck-
Williamson
Co.

II—STEAM.

The subdivisions of steam heating are four in number.

First—DIRECT RADIATION. This means that the heating surfaces or radiators are placed in the rooms to be warmed. The radiators warm the air already in the room. There is no incoming air except what leaks in around the windows and doors. The air

Steam—
1. Direct
Radiation
2. Direct In-
direct Radi-
ation

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3. Combination of both 1 and 2
4. Indirect Radiation

Direct Radiation

Never be Employed

that leaks in is colder than the air in the room and falls to the floor, causing cold, unpleasant drafts and cold feet for occupants. No fresh air is admitted to the room and no provision is made for the removal of the foul air—in short, no ventilation is provided, yet, this method is one that is particularly attractive to some, because it is in such common use. Its advocates have, perhaps, never had the opportunities to see something better or to trace the effect of no ventilation. This method is comparatively cheap in first cost, but costly in consumption of fuel and maintenance, and if the work is properly installed, it will give the required amount of heat. There are other reasons for and against this system which might be mentioned, but their statement is hardly necessary, for, as no ventilation, or at least, not sufficient ventilation is provided, our conclusion is that this method of heating a public building should *never be employed*.

Direct Indirect Radiation

System Obsolete

Principle Virtually Abandoned

Second—DIRECT-INDIRECT RADIATION. Direct-indirect radiation consists of placing the heating surfaces or radiators in the rooms to be warmed generally under the windows and always alongside outside walls. The air supply to these radiators is admitted through holes cut in the wall, back of the radiator. These openings have to be small. The largest do not exceed four by twelve inches, *i. e.* forty-eight inches in area for each radiator. The radiators must warm this air and also reheat the air in the room. In all rooms fitted with this class of radiation, we found the air supply entirely too small, never more than ten per cent. of the amount necessary to secure good ventilation, and even this small supply is not constant and positive. The wind blowing against the building often exerts pressure enough to drive the air into the room faster than the radiator can heat it, and if windy outside, this result drives dust and dirt into the room. This is especially true on the windward side of the house. On the leeward side of the building the currents of air are often *out* through the openings in the walls and this shuts off the fresh air supply altogether.

We learn that this system has never been a success, and in most instances where already introduced, the openings in the walls have been closed up, and the sole dependence for heating is upon the direct radiators. The system is practically obsolete, and the principle has been virtually abandoned.

Provide Insufficient Ventilation

A familiar example of steam heating with direct radiation is the Lewis and Clark County Court House, Helena; and as a familiar example of steam heating, direct-indirect radiation is found in the new High School Building of Helena. The most serious defect in these plans is that insufficient ventilation is provided, with great cost of maintenance.

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Third—COMBINATION DIRECT AND INDIRECT RADIATION. This system depends upon the Direct Radiation to furnish sufficient heat—and for ventilation, Indirect Radiation, consisting of a small air duct with an indirect coil at or near its base, and a fresh air supply carried to the base of this flue from a basement window. In every case we found these flues entirely too small, and the amount of indirect radiating surface insufficient. The objections to this system are: First, it does not furnish enough air for ventilation, and, second, if the duct were made large enough to supply the required volume of air, and if the indirect coil was made of sufficient capacity to heat the air to the proper temperature, the Direct Radiation would *not be needed at all*. In any building in which you find a combination of these two systems, it is safe to say that the Direct Radiation is put in to furnish the heat, and the Indirect Radiation for a bluff at ventilation and to quiet the clamor of those who demand it. This system is better than Direct Radiation because it does furnish some pure air, but it cannot be commended, because never in large enough quantity, and because of great expense in first cost and to maintain.

Cannot be
Commended

Fourth—INDIRECT RADIATION. Indirect Radiation is the placing of all heating surfaces or radiators outside the room to be heated, *and can only be used in connection with some system of ventilation*. There are two distinct styles of Indirect Radiation. One, we give the name Hot Blast or Forced System, where all the heating surface is placed in a chamber or coil, and the air impelled by a fan or blower, passes through them to be warmed and distributed over the building through air ducts. The second system is, where the heating surfaces are divided into many parts and placed near the lower ends of vertical flues, leading to the room to be heated by air warmed by being brought in contact with heated surfaces placed in some other room, usually in the basement or cellar. Either style of Indirect Radiation, if properly applied, will do excellent work. Our preference of the two, is for the first, or Hot Blast System.

Good if
Properly
Applied

This method is used in ships, war vessels, etc., and in large factories where large power plants are in operation. In these cases, the exhaust steam is used for heating, and the large radiating surfaces are warmed with little extra expense after the first cost of introducing the plant. Briefly speaking, the *Steam Hot Blast* apparatus includes the following elements:

First—A steam boiler for generating steam.

Second—Steam mains to deliver the steam at points desired.

Third—A group of steam pipes, suitably arranged in a casing or room made of either steel-plate or brick, between which air is

Description
of Steam Hot
Blast Plant

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**Description
of Steam Hot
Blast Plant**

either drawn or forced by a fan, the air being heated by passing between the steam pipes.

Fourth—A fan to draw the air between the pipes and force it into the building through ducts or flues.

Fifth—A motor with which to drive the fan.

Sixth—A suitable system of flues, dampers, and registers to deliver the heated air at the desired point and control its supply.

Seventh—Steam traps with an automatic steam pump and receiver, to keep the heater pipes free from water and to return the water of condensation to the boilers.

With this system, if all parts of the apparatus are of ample capacity and properly proportioned, the heating and ventilation of the building is positive and certain.

A hot blast or blower system of heating and ventilation with steam and fans, as same is being applied to-day to educational and public buildings, with all modern appliances, may be described as follows:

Fresh air is received in through windows or fresh air duct brought from a point below the roof. In front of this fresh air opening is placed a tempering coil, which is so arranged as to deliver the air to fan at a temperature of from forty to fifty degrees. Under the tempering coil is a large balanced damper through which fresh air may be admitted to the space between coil and fan without passing through the tempering coil. This damper is controlled by a thermostat placed in the tempered air near the fan inlet and set at forty degrees, Fahr. If the air coming through the tempering coil rises above forty degrees, Fahr., the thermostat immediately opens the damper admitting cold air sufficient to hold the temperature down to forty degrees. Should the temperature outside be so high that with the damper under the coil full open, that the air coming through the coil and open damper continues still to rise and go to fifty degrees, Fahr., immediately a second thermostat set at fifty degrees operates to shut a diaphragm valve shutting the steam entirely off from the tempering coils. This tempering air under control now enters the fan through its suction, is discharged from fan in one or two directions, as may be necessary, each outlet being fitted with a steel casing divided horizontally. In the space on one side of the division the air passes through without obstruction. In this way two conditions of atmosphere are produced, one tempered, being the same tempered air that enters the fan, the other hot by having passed through the heating coils just mentioned. Both of these conditions of air are independently connected to each room by a single pipe, which has a connection into each space in which are placed dampers set at right angles to each other. A thermo-

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stat is placed in each room, which controls the dampers in pipe leading thereto. This thermostat is set at any degree of heat you wish in the room, which is commonly seventy degrees. When the temperature of the room rises above seventy degrees and goes to seventy and a half degrees, this thermostat closes the damper that shuts off the heat air, and at the same time opens the damper that supplies the tempered air. One opening as the other closes, being set at right angles to each other, the flow of air is continuous. This tempered air then immediately commences to cool the room down, and when it reaches sixty-nine and one-half degrees, shuts the tempered air damper and opens the hot air damper, keeping up this operation continually, never allows the room to cool down or overheat, maintaining the temperature within one degree. These changes are never perceptible in the room, as no person can notice the slow change of one degree.

**Description
of Steam Hot
Blast Plant**

This system regulates the amount of heating surface in use to the temperature outside, and the temperature can be so nicely arranged that one can readily see a large saving in fuel, as unnecessary heating surface is never in use condensing steam when not needed, and the fan and engine being run at the same speed, the regulation can be kept at the required standard.

This, in the main, describes the Hot Blast or Blower process of heating and ventilation.

In this system, very often, direct radiation is used in connection with the toilet-rooms, and also on the entrances of the halls in extreme cold climates. This system should be installed in such manner that the same would serve also as a gravity system; that is, it should work without the use of the fan at least to such an extent as to keep the air in the room to at least sixty degrees. This will be particularly necessary in the Agricultural College in some departments, to keep the rooms fifty to sixty degrees above zero, so as not to disturb the germinating process, and to protect chemicals from freezing.

This system produces good heat through the building, with moderate ventilation at night without the aid of a fan, by leaving the cold air opening into the fans and heaters open at night and keeping steam on the coils, the rooms being heated by what might be called an indirect gravity system, the cold air coming in contact with the coils, heats and rises into the rooms.

It is evident that here the fresh air as provided by nature is warmed to the proper degree, forced into a room above the faces of the occupants, and then moving downwards and exhausted. In this way, the inhaling of the air used by somebody else is prohibited, and the exhaust from the different bodies is taken downwards out of the room instead of rising and assimilating with the heated air, to be breathed over again as in systems heretofore explained.

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As these above-mentioned steam systems are practically all in use, the fact resolves itself that to heat a room and produce two conditions vital to heating and ventilation so that a line of thermometers placed on the same level through a room from side to side, end to end, or corner to corner, will show the same degree of heat, and when tested for carbonic-dioxide, will show on the same level at all points, the same healthful condition of air, that, for steam heating, the hot blast system is the superior by far, provided, however, that the same be installed in the best manner as heretofore explained.

The objections to this system in buildings where little power is needed, and where the use of such a plant and the occupancy of the building is not continuous, are as follows:

**Objections to
an Indirect
Steam System**

First—High price for installation.

Second—Complication.

Third—Liability to get out of order and the cost of repairs and maintenance.

Fourth—Cost of labor to operate, as it requires a skilled and licensed engineer.

Fifth—Danger of freezing, or explosion on account of carelessness or neglect of janitor or engineer.

In the discussion of steam heating, such systems are condemned as do not allow for the admission of sufficient fresh air for ventilating purposes. It must not be forgotten that this is but one-half of the process necessary for perfect ventilation, and there must also be some means for removing foul air from the room, so that the fresh air can enter. The most convenient method for this latter process is by the help of ventilating stacks. These stacks must be of sufficient size and capacity to carry away all the foul air from the room. The size of the outlet and location of same, and the failure to heat the stacks, or in some other effective way to cause it to exhaust the foul air so that the warm fresh air can enter, often causes failure; therefore, it is a prime necessity that the system which will provide for the proper admission of fresh air will also provide as effectual and positive a completion of the process of ventilation by exhausting the foul air. The use of the second method of Indirect Radiation is only successful when the above is understood and practiced. On the above basis, we find that all systems of steam heating should not have favorable consideration (in the kind of buildings we are erecting) save the last two mentioned, viz.:

First—Steam heating by indirect radiation with gravity exhaust ventilating, and

Second—Hot blast indirect radiation steam heating with the same, or fan in the ventilating stacks.

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III—HOT WATER.

Hot water heating is divided into the same styles or classes of heating as steam.

The difference between heating buildings by steam and hot water is this: With a steam system, steam is circulated through the pipes and radiators, and with a hot water system, hot water is circulated through the pipes and radiators. We will consider only the open expansion tank system of hot water heating, as the closed tank or pressure system is deemed dangerous and should never be used.

Wm. J. Baldwin, C. E., in his recent book, "Hot Water Heating and Fitting or Warming Buildings by Hot Water," says: "But the practice of closing a tank should be condemned for house warming, for a mistake in the amount of water in the apparatus will upset all calculations, and it is almost impossible to estimate the pressure that can be obtained with a closed tank. With steam, the temperatures and pressures always bear a fixed relation to each other; when in the presence of water, so that knowing the one, the other can always be found. With water in a non-elastic vessel, however, and subjected to heat, the pressure may become enormous, although the temperature is comparatively low. Should water at a temperature of three or four hundred degrees burst its envelope, a large part of it will instantly fly into steam and the damage that will follow will be just as disastrous as though a steam boiler blew up with steam at a pressure corresponding to the temperature we have supposed for the water." Advocates of hot water systems claim that they are more economical in the consumption of fuel than steam but we could not obtain positive facts in this line, but the heat is easier controlled by the fire, and thus a saving is arrived at in moderate weather, and is also more comfortable for the occupants. Heat is distributed by the contact of air with the radiating surfaces. In the hot water application that contact reduces the temperature of the water in proportion to the heat transmitted from the water to the air, and the water containing the remaining heat circulates back to the boiler, where it absorbs additional heat and is again started on its mission of circulation and transmission. Radiation must be larger, and this makes the installation of the hot water system much higher in price. Hot water radiators take up more floor space and add more weight to be supported. There are other things to be considered, such as the longer retention of heat by the hot water apparatus, etc., but the buildings which require a great quantity of fresh air to be supplied, and the great amount of radiating surface necessitated, make this method almost prohibitory on account of first cost. Also the same objections found to the different systems of steam heating are equally applicable to

**Hot Water
Systems Not
Favored in
Cold Climates**

**Danger of
Closed
Expansion
Tanks**

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hot water heating, in addition to the largely added danger of freezing and bursting of boiler, pipe and radiators.

IV—WARM AIR FURNACES.

**Warm Air
Furnaces**

The furnace system of heating is an indirect system under all circumstances. It can be divided into three classes:

First—Heating by furnace without ventilation.

Second—Furnace heating and ventilation by the gravity system, and,

Third—Furnace heating and ventilation by mechanical or hot blast system and fans to control the circulation of air.

Objections are raised to all heating and ventilating systems, and the warm air system is not an exception. It is urged against the first-mentioned system that the joints will open by expansion and contraction of the highly heated metal, that the gases will escape into the hot air ducts and in the rooms to be heated; that the air, in passing through the furnace, becomes superheated, thus delivering impure air into the rooms.

Furnace heating without ventilation has nothing to commend itself except its economy in first outlay and the cost of maintenance. It is not durable. It is not clean. The furnace usually delivers heat at a high temperature into the room, and as no provision is made for the exhaust of the air, occupants are oppressed with foul air, overheated, subject to drafts from open windows, which will be pulled down at the top, etc. It is a familiar story, and previous suffering has bred a general prejudice against the very name of furnace.

**Best Result
in Furnace
Heating**

Furnace heating, by either of the other methods mentioned above, is quite another thing, and, like an indirect system of steam heating, if properly introduced and introduced in proper places, will give the best results.

**Gravity
Furnace
System**

The gravity system of furnace heating and ventilation is really an *exhaust system*, but to distinguish it from a *Mechanical Exhaust System*, it is called a "Gravity System." The successful operation of both heating and ventilation is brought about by gravity, which always causes a cooler strata of air to fall by its weight and by the attraction of gravitation, and a column of hot air to rise, by rarification (heat). In this system the furnaces are placed in the basement, most properly at the base of the brick air ducts leading to the rooms to be warmed and ventilated. At the extreme bottom of these flues or ducts and in the sides next to the furnace is an opening for the admission of cold air, and at the top of the furnace casing, is another opening into this same flue for the admission of warm air. At the bottom of the warm air opening is a valve to control the admission of the air to the room

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above. If the valve is placed in another position—all cold air will enter the room. By setting this valve at any point between the two extremes, the temperature of the air can be regulated to any degree between the coldest outside temperature and the warmest air in the furnace chamber. The valve is controlled by a regulator in the schoolroom, and the occupants of each room are thus able to control the temperature of the room and change it to any degree required, independently of any other room in the building. While this valve regulates the temperature, it does not *reduce the air supply* going into the room, the supply being constant under all circumstances or conditions of the elements outside the building. The valve in the schoolroom can be operated by either hand or automatic regulation. The air supply for the schoolroom is taken from outside of building into a cold or fresh air room which is of easy access and the air supply is easily regulated. The room should be kept sweet and clean. This will insure the delivery of the air through the furnace into the schoolroom, in as pure a condition as it is out of doors.

The Furnace which warms the air must be capable of warming an immense volume of air, and so thoroughly doing its work that no one portion shall be so heated as to favor certain rooms; simple in its construction so that its operations can be readily understood by the average janitor; so constructed that all joints will properly adjust themselves to the varied conditions of heat and cold; gas tight, and have a radiating surface that is properly proportioned to its grate surface. Consideration of these facts proves conclusively that it is not the furnace, which by its superior construction concentrates the heat, or a furnace in which an intense heat can be quickly obtained, but a furnace which spreads the heat *most evenly* over the largest extent of heating surface with slow combustion, which are the points to be sought for. The successful operation of all indirect heating systems depends on the venilation of the rooms, for the reasons that the impure air must be exhausted from a room before the pure air can flow in. Thus, we see that ventilation is an aid to the heating, and proper heating is an aid to ventilation.

We have examined a great variety of furnace heating and gravity ventilating apparatus in the different cities, many of them working to perfection.

The last method of heating and ventilation we will consider is a mechanical or hot blast furnace system. The following elements go to make up the complete apparatus:

First—Warm air furnaces set in a central location in a battery or separately at the base of the heat risers.

Second—A fan to force or draw the air through and over the furnaces, and force it into the building through ducts and flues or heat risers.

**This is the
Description
of a Peck-
Williamson
"Gravity
System" in
the Walnut
Hills High
School,
Cincinnati.**

**Working to
Perfection**

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**Hot Blast
Furnace
System**

Third—A motor, which can be either an electric motor or a gas or gasoline engine or a water motor, with which to drive the fan.

Fourth—A suitable system of flues, valves, and registers to deliver the heated air at the desired points and control its supply.

The Plenum system keeps the air in the furnace chamber, the air distributing ducts, and the air in the rooms under a slight pressure, in this manner forcing it out at the different outlets provided for the escape of foul air.

The exhaust system is the reverse of this, as it exhausts the air out of the rooms, and at the same time pulls the air from the furnace into them. In the majority of buildings, the Plenum Mechanical System is to be preferred to the Exhaust Mechanical System.

**The High
School,
Kenton, O.
Work of
The Peck-
Williamson
Co.**

We can best describe a mechanical or hot blast furnace system of heating and ventilation, by giving a detailed description of a heating and ventilating plant which we visited in our investigations. From anemometer tests we found that there were from thirty to forty cubic feet of air per minute being furnished each pupil, in each room, to the full seating capacity of each room; that the temperature was uniform at the same height from floor, and that the difference in temperature between floor and ceiling did not exceed four degrees. The heating and ventilating plant is a combination of a Plenum and a gravity system, but we were informed that, unless the weather was very cold and windy, it is not necessary to run any mechanical appliances, as the building heats and ventilates perfectly by gravity exhaust. In extreme windy weather the mechanical appliances are used, and uniform heating and thorough ventilation are secured, no matter what the condition outside. The building is warmed by six masonry furnaces set in a battery, in a central location. The fresh air supply to the furnaces is through an underground fresh air duct connecting the furnace chambers to the fresh air room. The fresh air room is arranged to take air from two directions, west and north. The heat risers to the different rooms are of brick and are arranged to furnish either warm or cold air through the same register; the cold air connections to the risers being brick ducts underground, and the warm air connections being galvanized ducts overhead. In the fresh air rooms is located a fan to force the air through the furnace to the different rooms. This fan is used only in extreme bad weather. The fan is operated by a five-horse power motor. This system of ventilation is reinforced by coils at the top of the ventilating stack, the air from each room being exhausted into a ventilating flue or flues, all of these flues terminating in the attic. There the ventilating flues are all connected with a central foul air chamber by galvanized iron ventilating ducts, and the air is

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exhausted from this foul air chamber to the outer air through a galvanized iron ventilating top, made double to keep it from chilling. This ventilating top is eight feet six inches in diameter. The Assembly Hall is the height of both the first and second stories of the building, and is furnished with a stage and seats for 460 people. It is arranged to ventilate from the floor in cold weather and from the ceiling in warm weather, to keep it cool. With this arrangement, by running the fan and forcing the air into the room at a high velocity, and exhausting the air from the ceiling in warm weather, it will keep the room cool and comfortable.

NOTE.—The only building which the Committee took pains to describe is the above building, *i. e.* the Kenton, Ohio, High School—a Hot Blast Furnace System. This, with the Walnut Hills High School, Cincinnati, Ohio—a Gravity Furnace System—were selected by the Committee as the two best working plants they saw in the matter of heating, ventilation and sanitation, and both buildings were equipped by the Peck-Williamson Co.

TWO GENERAL SYSTEMS.

Taking the measure of good ventilation as a standard, we weed out all methods which do not provide for it, and this leaves for our consideration two general methods of heating, viz: Steam Heating and Warm Air Heating, and but two subdivisions in each class, viz:

A.—Steam heating by indirect radiation and gravity ventilation.

B.—Steam heating by indirect radiation and hot blast ventilation.

C.—Warm air heating by the gravity system of ventilation.

D.—Warm air heating by hot blast system of ventilation.

In comparing indirect heating and ventilation above mentioned, and granting that good construction in either will give *equally* as good results, we come to consider the other items of Safety, First Cost, and Cost of Management and Maintenance.

Safety. It will be immediately granted that a warm air or furnace system is, when properly installed, a *safe system*. It will not set the building on fire, and it cannot blow up or freeze up. It will also be granted that there is no danger from fire with a steam system properly installed.

We are considering the matter as it relates to the installation of a heating plant in our public buildings in Montana. We have never given this matter of the safety of a steam boiler much thought, because fortunately we have never had a boiler explosion in any of our public buildings.

NOTE.—Under this head the marked preference is given to a furnace system as compared with a steam system.

Comparisons
as to Safety,
First Cost,
Cost of Man-
agement,
Cost of Fuel,
and Main-
tenance

1st—Safety

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1st—Safety

This may be attributed to the fact that all of our buildings fitted with steam heating apparatus are comparatively new. But it is a startling question, and we now feel satisfied that danger exists and an explosion may happen at any time, and we would recommend that all steam boilers in use in our public buildings be subjected to a rigid inspection, and if found in a dangerous condition, that they be immediately made as safe as possible, or removed and a safe apparatus put in. We also think that our Legislature should be asked to pass a rigid Boiler Inspection Law, making the same applicable to heating plants. To give you some *idea of the danger* in the use of *steam boilers*, we refer you to the following reports from State Inspectors and also to the daily press, for since attention has been called to it, we note that hardly a day passes that some such accident does not occur in some portion of the country.

The State of Massachusetts is divided into districts, and each district is in charge of a district inspector. These inspectors make an annual report to Rufus W. Wade, Chief of Massachusetts District Police and Chief Inspector of Factories and Public Buildings. Chief Wade makes a detailed report of all the District reports to the Governor of the State, and we quote from his reports relating to the dangerous condition of boilers and the incompetency of men in charge of them. The summary of this report for 1893 is as follows:

Out of a total of 171 boilers inspected, 481 defects were found, and 114 were pronounced dangerous. In conclusion, Chief Wade says: "I cannot too earnestly recommend the enactment of a law providing for the inspection of all steam boilers and the *licensing* of all persons in charge thereof . . ." "The safety of the public requires this safeguard." In the report of 1894, we found fourteen pages devoted to defective boilers and incompetent persons in charge, and he ends with the following summary and recommendation: "Number of boilers inspected, 405; number of defects, 842; dangerous, 169. My previous reports have called attention to the fact that defects in boilers are very common in school-houses, and they are decidedly more dangerous because the steam is liable to be shut off entirely by the teachers, and the janitor is away, with no one to take care of the hot fire. There are other boilers in use equally as dangerous, and as they are never inspected, no one knows anything about them. The janitor gives them scant attention, and every one about them is living in fancied security; that being low pressure boilers they can never do any harm. Quite a number of these low pressure boilers have exploded lately and with disastrous results. They are safe if properly designed, so long as the pressure is low, but the inability to keep the pressure low is a defect very common in many of them. Every safeguard should be provided and made compulsory

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to guard against increase in pressure, as well as against deterioration in the boiler.

First Cost: This is a determination hard to arrive at, because no two buildings are alike, and therefore, the first cost will differ. The information we can obtain, however, leads us to believe that the *first cost of a steam system will be much greater than the first cost of a warm air system.*

NOTE.—Preference is here given to a furnace system.

Cost of Management and Maintenance: The cost of maintenance is the cost of labor and the cost of fuel. On the first item we have shown that, in the *management of a steam plant* with safety, a licensed engineer is necessary, and his presence should be continuous about the plant. *This kind of labor is high priced, and involves an extra expense for janitor services.*

In the *management of a warm air plant*, on the other hand, we found the *janitor able to do both.* In the matter of cost for repairs we have no reliable data, and can only judge from our own observation. This would lead us to conclude that the necessary *repairs for a steam heating plant would greatly exceed the wear and tear on a less complicated furnace system.*

NOTE.—Under this head also they find a saving in the use of a furnace system.

In the matter of fuel consumption we have more definite information. State reports and individual experiences furnish data upon which estimates may be made and conclusions drawn. From our researches and personal inquiry of parties in charge of different systems of heating plants we are led to believe that the cost of fuel under the *furnace system*, when the same is properly installed, is fully *one-third less.*

NOTE.—They find cost of fuel much less with furnace system than with steam.

We have often been puzzled in reading reports of the expense of heating and ventilating of buildings to notice the vast difference in cost, not only in different localities and systems, but in the same system and in the same locality. Our investigation on this point has led us to the conclusion that some of the reasons are: The quality of fuel and difference in faithfulness and efficiency of attendants, or their control by the principals or teachers or of the teachers themselves. The above are potent causes for success or failure. But another, and not the least reason, is found in the kind and quality of materials used in the construction of the building proper. In this latter respect, we have found that the thermometer indicated on a solid brick wall twelve degrees less on the windward side than on the leeward, and these differences are especially noticeable in Montana on account of greater prevalence of wind. This caused us to give attention to hollow walls, and walls constructed of hollow brick, or brick with hollow tile linings. The latter we found nine and one-half degrees warmer than the

2d—First Cost
of Plant

3d—Cost of
Management

4th—Fuel
Consumption

Some
Reasons for
Success in one
Location and
Failure in
Another,
Where the
Same System
is Used in
Both Places

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solid brick walls, and this great difference in temperature, when considered for the whole outside wall of the building, would indicate that it is a point of economy well worth attention. To a large extent, also, should the subject of storm doors and double windows be considered and adopted in this climate.

Natural gravity is preferable, with a system as simple as possible. The carrying of supply or exhaust pipes on a level for any distance, we found very detrimental to a satisfactory working, particularly if said pipes are carried through a cold room. In several instances where the exhaust pipes were carried ten feet and more to a central exhaust shaft, the exhaust was diminished to such an extent, that the supply was also seriously interfered with. This will be particularly noticeable if no mechanical force is employed with the supply. We find that it is not a very difficult matter, neither does it require large expense to change the air in a room six times per hour; or if applied to persons, it should be thirty cubic feet of air per person per minute. Unpleasant drafts must be avoided under all circumstances. This can be done by proper inlet and foul air outlets without any difficulty.

**Should Heed
the Advice of
the Expert of
the Heating
System
Selected**

In answer to the question, what is the best form of construction, or rather, which method of *warm air heating* we should use in the particular buildings we have under consideration, we would advise that it rest largely upon the advice of the engineer of the heating system we adopt. His experience in hundreds of buildings of a like character should render his opinion of more value, and it should be given more weight than that of those of less experience or a more limited information.

SANITATION.

The last subject which we present for your consideration, and this is a matter of equal importance to that of heating and ventilation, is the sanitariums, or closets, and urinals, to be used in our public buildings.

**Common
Water Closets**

Individual water closets, particularly water closets that act separately or independently from each other are too numerous in the market to specify in detail.

Closets of this class are not a sanitary appliance, and as there are so many traps, tanks, and ball cocks to get out of order, we think they are neither sanitary, durable or economical. Therefore, we think they should never be used in a public building.

One closet, however, a home production, which we did not have an opportunity to investigate until our return to Helena, seems to overcome many objections. The ventilating feature is better than any of the single closets we have seen.

**Range
Closets**

The number of different makes of range closets on the market are almost as numerous as the number of companies manufacturing plumbers' supplies. There are many objections to

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some of this class of closets from a sanitary standpoint, but these objectionable features are more nearly overcome by the appliance of a double flushing, automatic flushing and ventilating closet, than by any other we have seen. These closets are a new departure in sanitary work, and are constructed in accordance with the most rigid plumbing laws. They are perfectly ventilated and odorless.

The closets are automatic in action, flushing each pedestal seat, and also through latrines under the floor. The urinals are made of glass, slate or marble, washed with a continuous flow or veil of water, and both seats and urinals are ventilated both above and under the floors.

Exhaust ventilation is also provided for the room in which the closet is placed, to the extent of changing the air once in every eight minutes, or eight times per hour. The tank is a model of simplicity. All the working parts are out of the water, and it stays in working order, is automatic in action, and flushes every time the tank fills. The tank has a *secondary* flush which is used to fill the bottom of the latrine, after the main flush, with three inches of water standing until the next flush, and all deposits consequently fall in water.

The hydrant full open will fill the tank and flush once in about five minutes. By partially turning off the hydrant, the period between the flushings can be regulated at will. At night, or whenever the closets are not in use, by lifting the valve when turning off the hydrant, the whole apparatus will be clear of water, and there will be *nothing to freeze*.

The usual size holds, when full and ready to flush, about forty gallons of water—a supply sufficient for from fifteen to twenty-five closets or stalls of urinals. Once decide how often you wish it to flush and turn on the water in sufficient quantity to fill the tank in the length of time you desire, and the apparatus *will take care of itself for an indefinite period*.

In this construction the closet and urinal vault is connected directly with the ventilating stack, and the exhaust of the stack is from the room through the closet vault into the stack, therefore, the odors, etc., are never perceptible in the room, in fact are never permitted to escape into the room or rooms of the building.

DESSICATING CLOSET.

Another form of closet to be used where no sewer or water is available is what is called a dry closet. The process is one of evaporation of the liquid deposits and the final cremation of the dry solid residum. There should not be and there is not in the system any connection whatever between the ventilating ducts and stacks for the school-rooms

This is a
Description of
the Ensign
Patent Flushing
Closet,
which is
Owned and
Manufactured
by the Peck-
Williamson
Co.

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This is a
Description of
the Peck-
Williamson
Co's
Dessicating
and
Cremating
Closet

and the ventilating ducts and the stacks for the closets. These two are positively separated and work independently of each other. The air used for the evaporation of the liquid in the *dry closets* comes from an outside window and is discharged into a separate closet vent stack. In the vent stack a stack heater is placed, and in the fresh air room, at the other end of the closet vault, a vault heater is placed. This construction compels all foul odors, etc., to pass *through fire*, whether they flow up the stack, as is intended, or whether they reverse, as is not intended, but which may happen. In either event, the foul odor, etc., passes through fire, which is the best disinfectant, and are discharged into the outer air. It is *never possible* that they be drawn into the school-rooms.

Manufac-
tured for Use
Where no
Water or
Sewer
Connections
can be made

Another very important feature is that the closets are in immediate connection with the vent stack and the foul odors pass, directly they are made, into the stack and never through an intermediate space. Most attempts to ventilate the closets in a building are by a vent register in the *room*. The foul smells pass through the room to reach the outlet. In this closet the exhaust is *from* the room, *never through* the room.

Some
Conclusions

Filthy air is as disgusting as foul water, and no more conducive to health. In the homes of people a generation or two ago, the evils of a lack of ventilation were somewhat lessened by the open fireplaces and the methods of building houses. It is one of the primary truths of sanitary science that perfect drainage, complete ventilation and cleanly surroundings, are necessary conditions of life. It was once deemed sufficient, in order to ventilate a room, that some device should be provided to force into it a current of fresh air. The better method provides that there shall be an intimate relation between the heating and ventilation, and that system can only be depended upon which is best adapted to expel foul air, and introduce fresh air at the same time and in sufficient quantity.

Acknowledg-
ments

Acknowledgments are due to many state and city officials, and to other public and private individuals, for courtesies extended, and for time and trouble taken to aid us in our quest for information on these subjects. There was magic in the name of our State, and it invariably brought us privilege and courtesy wherever we went.

Word of
Special
Advice

The most emphatic of our impressions, and the one word of advice to which we would have you listen, in all the words of this report, and the one result which we would have, above all others, to be the consummation of the work of our investigation, is, that the public buildings of this great Commonwealth *be models of perfect sanitary construction*. Better than mines of treasures; better than acres of golden harvest; better than stores of knowl-

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edge, is a legacy to our children of "Good Health," and the means to preserve "Good Health." What value have the good things of life without it?

Thanking you for the pleasure and privileges your Commission has given to us, individually, this report is,

Respectfully submitted,

(Signed)

T. E. COLLINS, Chairman.

(Signed)

JOHN C. PAULSEN, Secretary.

(Signed)

WALTER COOPER.



ADDENDA.

The Editor wishes to add a few references, and mention a few among the number of contracts which The Peck-Williamson Co. now have in process of construction, (summer, 1896) in this the busiest year of our history.

To give some idea of the measure of favor which our apparatus is receiving, we will mention that our present contracts in public buildings number, on an average, more than one per day.

In the fall of 1895, we were awarded contracts for the "heating and ventilating" of the following buildings in Los Angeles and Pasadena, California:

LOS ANGELES.

Olive Street School, twelve rooms;
Peco and Sentuse Streets School, twelve rooms;
Twenty-first Street School, ten rooms;
Temple Street School, ten rooms;
Twenty-eighth Street School, ten rooms;
Seventh Street School, ten rooms;
Vernon Avenue School, eight rooms;
Union Avenue School, eight rooms;
Macy Street School, eight rooms;
Griffin Avenue School, eight rooms;
Gates Street School, eight rooms;
San Pedro Street School, eight rooms;
State Street School, eight rooms.

PASADENA.

Franklin School, eight rooms.

The following quotations are selected from the Los Angeles press, when these buildings were completed and tested:

From the *Los Angeles Evening Express* of March 23, 1896:

The new schools are constructed on plans which combine a comprehensive knowledge of the best thought in the manner of Ventilation and Heating; in fact,

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they have touched very closely on the rigid ideas of simplicity, which governed the philosophers of ancient Athens, in that, the architect has given the rising generations of Los Angeles, a glorious privilege of breathing pure air and plenty of it.

The heating and ventilating is far from being the least noticeable of a remarkable bit of public work of which all who had aught to do with it may be well proud.

The *Los Angeles Herald* of March 23, 1896, in speaking of the school buildings, says:

There is nothing of more value to any school building, than plenty of pure air, and the plants placed in the structures just completed leave, in this particular, nothing to be desired. The new Los Angeles schools, are the only buildings of this character, in this State, which are, in reality, perfectly equipped.

The *Los Angeles Times*, March 23, 1896, in speaking of the new school buildings, says:

The halls are wide, running the entire length of the buildings, and more than any other feature, saving the complete heating apparatus of the building, excited the admiration of the Council who have been careful to see that their respective wards were properly treated by the architect and contractor.

The premium obtained by the sale of the bonds enabled the Council to put in the most modern heating plant that is known. The system as it is in operation now provides a complete change of air every eight minutes.

In May, 1896, at the conclusion of the first year's use and test of the apparatus, the following expression was received from the Boards of Education:

PASADENA, Cal., May 9, 1896.

To whom it may concern:

This is to certify that the Peck-Williamson Warming and Ventilating Apparatus put in the Franklin School Building at this place gives entire satisfaction, and we can fully recommend the same to any one who may be in need of a thorough warming and ventilating system in any public building. The system put in for us is all and more than they claimed for it.

Statement of amount of fuel used when both warmers and stack heaters are used every day: The amount of fuel "soft coal" used is one ton per month, in ordinary weather when fire is needed, or about one-half the amount of fuel used in the Columbia Building, where a * rival system is used.

Respectfully,

CALVIN BARTWELL, President.

LOS ANGELES, Cal., April 10, 1896.

This is to certify that the Peck-Williamson Heating and Ventilating Company, of Cincinnati, Ohio, has furnished and erected in place in thirteen of our new school buildings their heating and ventilating system.

Our specifications required thirty cubic feet per minute per scholar of fresh or warm air. On making a test with scientific instruments we have found the apparatus to furnish from forty-five to sixty feet per minute, or nearly double the amount required by contract. The various rooms are evenly heated, the circulation of air being uniform throughout. This work has given thorough satisfaction.

CHAS. L. STRANGE, Superintendent of Buildings.

E. C. BLANCHARD, Chairman Building Committee.

FREEMAN G. TRED, President City Council.

*The other system referred to above is the same which is mentioned below in the following letter from the Mayor of Oakland, Cal.:

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J. L. Davie, Mayor. OFFICE OF THE
MAYOR OF THE CITY OF OAKLAND, CITY HALL. }

OAKLAND, Cal., July 24th, 1896.

Hon. J. F. Jordon, Member City Council, Visalia, Cal.:

Dear Sir:—The City of Oakland has thrown away \$50,000 for heating and ventilating apparatus in the various school buildings, placed therein by the Smead, or Morgan, Co.

The Morgan System is expensive to operate, the original cost is excessive, and the area occupied by flues, etc., in the schoolrooms is beyond a reasonable limit. The system is absolutely unnecessary in a climate of the character of that of Oakland or Visalia.

From a careful investigation of the heating system now in the Oakland schools, I cannot recommend the Smead, or Morgan, System, for many reasons not herein enumerated.

As Mayor of Oakland I would be pleased to entertain Councilmen that may be delegated to inspect the heating systems of our schools.

A significant fact in connection with the number of school buildings proposed to be constructed throughout the State this year, is the activity of certain architects, school superintendents, and the Morgan Co., recommending their construction.

Respectfully,

J. L. DAVIE, Mayor.

The following contracts are selected among the number now in process of erection:

ST. LOUIS, MISSOURI.

Heating, Ventilation, or Sanitation in Fifteen Ward Schools—twelve-room buildings or larger.

The following wire will be of interest—addressed last summer to our Manager in San Francisco:

ST. LOUIS, MO., May 13, 1896.

Peck-Williamson Flushing Closets best ever used; installed them in four (4) buildings last year. Specified them for fifteen (15) this year.

MEMBER BOARD OF EDUCATION.

CINCINNATI, OHIO.

Elm Street School, twenty-four rooms—Heating, Ventilation and Sanitation.

CINCINNATI, O., May 13, 1896.

We consider the Peck-Williamson Closets the best on the market. We use them in our new buildings and have torn out Smead Closets, and installed Peck-Williamson Closets in our buildings.

JACOB E. CORMANY, Chairman,
Building Committee Board of Education

BLOOMINGTON, ILLINOIS.

High School, thirty-six rooms—Hot Blast, Heating, Ventilation and Sanitation; also, the Lincoln School.

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OGDEN, UTAH.

New High School.

OGDEN UTAH, May 15, 1896.

PECK-WILLIAMSON Co., San Francisco.

Flush Closet System placed in old High School building, October, 1893; perfect success; has never given one minute trouble; will use same system in new High School building this year.

A. C. EMERSON,

President Board of Education.

KOKOMO, INDIANA High School and two Ward Schools.

MT. PLEASANT, PA. . . . High School.

SUNBURY, PA. High School.

OLEAN, N. Y. High School and one Ward School.

RICHMOND HILL, L. I. . . Two Ward Schools.

OXFORD, N. Y. High School.

RANDOLPH, N. Y. Chamberlain Institute.

CATSKILL, N. Y. High School.

HAVRE-DE-GRAS, MD. . . High School.

JACKSON, MISS. State Deaf and Dumb Asylum.

HOUSTON, TEXAS City Hall and Jail.

OSSIAN, IOWA Public School.

CRESSO, IOWA High School.

BATTLE CREEK, MICH. . . High School.

DETROIT, MICH. Amos School.

CLEVELAND, OHIO Ward School.

COLUMBUS, GA. United States Post-office Building.

MONTGOMERY, ALA. . . . High School.

FREEPORT, ILL. Three Ward Schools.

SCOTTDAL, PA. High School.

ALLEGHANY, PA. Second Ward School.

FRESNO, CAL. New High School.

CHICO, CAL. High School.

